

ENGINEERING STANDARD
FOR
428B - IRRIGATION WATER CONVEYANCE (FT)
FLEXIBLE MEMBRANE DITCH AND CANAL LINING

Definition

A fixed lining of impervious material installed in an existing or newly constructed irrigation field ditch or irrigation canal or lateral.

Scope

This standard applies to buried membrane linings made of flexible materials, such as plastic, rubber, or asphalt. It includes design and construction criteria for the ditch section that affects the installation of the lining as well as for the lining itself.

Purpose

To prevent waterlogging of land, to maintain water quality, and to reduce water loss.

Conditions Where Practice Applies

Ditches and canals to be lined shall serve as an integral part of an irrigation water distribution or conveyance system designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Lined ditches and canals shall either be located where they are not susceptible to damage from side drainage flooding or they shall be protected from such damage.

Design Criteria

Capacity

A lined ditch or canal shall have enough capacity to meet its requirements as part of the planned irrigation water distribution system without danger of overtopping. Design capacity shall be based on the following, whichever is greater:

1. The capacity shall be enough to deliver the water needed for irrigation to meet the design peak consumptive use of the crops in the area served.

2. Capacity shall be enough to provide an adequate irrigation stream for all methods of irrigation planned for use in the area served.

Velocity

The velocity in canals or ditches lined with flexible membranes shall not exceed the nonerosive velocity for the soil material used for the protective cover or the material through which the canal or ditch passes, whichever is less. Local information on velocity limits for specific soils may be used, if available. If such information is not available, the maximum design velocity shall not exceed those shown in Figure 6-2, Chapter 6, SCS TR-25, except that the design velocity shall not exceed 3ft/s.

The velocity in ditch reaches from which water is to be delivered onto the field through turnouts, siphon tubes, or similar means shall be less than supercritical and sufficiently low to permit operation of the planned takeout structure or device.

Canals and laterals lined with flexible membranes must be designed with enough capacity to carry the required flows at the velocity that will be developed under the maximum probable retardance conditions.

For capacity design, the value "n" shall be selected according to the material in which the canal or lateral is constructed, the alignment, the hydraulic radius, and the potential weed and moss hazard.

For checking designs to see that velocities do not exceed permissible values in erodible soils, a Manning's "n" no greater than 0.025 shall be used.

Freeboard

The required freeboard varies according to the size of the ditch or canal, the velocity of the water, the horizontal and vertical alignment, the amount of storm or waste water that may be intercepted, and the change in the water surface elevation that may occur when any control structure is operating. The minimum freeboard for any lined ditch or canal shall provide 2 in. of lining above the designed water surface. This minimum freeboard requirement is based on the assumption that the finished channel bottom elevations will vary no more than 0.1 ft. from the design elevations. If a construction deviation greater than 0.1 ft. is permitted, the minimum freeboard shall be increased.

Side Slopes

Canals and ditches with buried membrane linings must be constructed with side slopes that will be statically stable. Slope requirements vary according to the type of cover material, but the side slopes shall not be steeper than 3:1.

Protective Cover

Membrane linings shall be protected by an earth or an earth and gravel covering not less than 6 in. thick and must extend not less than 6 in. above the top edge of the lining. In areas subject to traffic by livestock, the minimum thickness of the protective cover shall be 9 in. The material on the bottom 3 in. of cover shall not be coarser than silty sand.

Membrane Thickness

The required membrane thickness depends on the expected subgrade conditions, the hydrostatic forces that will be acting on the membrane, and the susceptibility of the lining to damage during or after installation. The minimum nominal thickness shall be:

Material	Asphalt	Plastic Sheeting	Nonreinforced Rubber	Reinforced Rubber
	mil	mil	mil	mil
Coarse soils (SM-SP-SW)	225	8	30	20
Gravel (GC-GM-GP-GW)	---	12	30	30

Water Surface Elevations

All lined ditches and canals shall be designed so that the water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to provide the necessary head, the backwater effect must be considered in computing freeboard requirements. The required elevation of the water surface above the field surface varies according to the type of takeout structure or device used and the amount of water to be delivered. A minimum head of 4 in. shall be provided.

Related Structures

Plans for ditch or canal lining installations shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conversation irrigation. These structures can be installed before, during, or after the lining placement. They must be constructed or installed in such a way as to not damage or impair the effectiveness of the lining.

Materials

Flexible membrane liners shall equal or exceed the physical requirements indicated for materials under "Specifications."

Plans and Specifications

Plans and specifications for installing flexible membrane irrigation ditch and canal lining shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

CONSTRUCTION SPECIFICATION
FOR
428-B - IRRIGATION WATER CONVEYANCE
FLEXIBLE MEMBRANE DITCH AND CANAL LINING

Scope

This item shall consist of the excavation, preparation, and appurtenances required for placement of the flexible membrane lining.

Construction operations shall be accomplished in such a manner that erosion, air, and water pollution will be minimized and held within legal limits. The completed job shall be workmanlike and present a good appearance.

Installation

Preparing Subgrades

Subgrades on which flexible membranes will be placed shall be raked to remove all large clods, roots, brush, sod, or rocks that might endanger the membrane. Rolling the subgrade is recommended to provide an extra measure of safety against punctures. In rocky areas, a cushion layer of fine soil shall be provided as a protection against irregularities that cannot be removed by rolling.

Placing Membranes

Plastic and rubber membranes shall be carefully spread in a relaxed condition over the raked and smoothed subgrade. Rubber sheets may be pulled out smooth, but all liners shall be installed in a relaxed state. For polyethylene film, care shall be taken to insure that at least 5 percent slack is provided. Prefabricated asphalt membranes shall be pulled out so that they lay flat on the subgrade.

If the width or length of the lining specified requires placing sheets together, all joints shall be watertight, and the strength of the bonded seam in any direction shall not be less than 80 percent of breaking strength (ultimate tensile strength) of the membrane when the specimen is pulled in shear.

Anchoring Membranes

Small anchor trenches about 10 in. wide and 12 in deep shall be used to anchor the side of the membrane. These trenches shall be located along the berm on both sides of the canal. They shall be a minimum of 4 in. back on the berm from the top of the side slope and at the elevation required to maintain the specified freeboard. The membrane shall conform to the trench shape and shall extend a minimum of 8 in. up the side opposite the canal. The trenches shall be carefully backfilled and compacted after the membrane is in place.

The upstream end of each section of plastic or rubber membrane shall be anchored in a trench dug across the canal. This trench shall be about 10 in. wide and 12 in. deep and shall connect with the two side anchor trenches. The upstream end of the membrane section shall lap down a minimum of 12 in. into this transverse trench. After the membrane is in place, the trench shall be carefully backfilled with selected compacted material. Prefabricated asphalt membranes shall be anchored at the upstream end of the lining section and at such intermediate points as are specified for individual jobs.

No anchors shall be required at the downstream end of membrane sections. The downstream end of the membrane shall be lapped a minimum of 3 ft. over the anchored upstream end of the next section. Placement of the protective cover material will secure the joint.

Placing Protective Cover

Material to be used as protective cover on membrane linings shall be free of large clods and sharp rocks and shall be carefully placed to the specified depth without damaging the membrane.

Construction Operations

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The completed job shall be workmanlike and present a good appearance.

Materials

The flexible sheets or films to be used as buried membrane linings in irrigation ditches or canals shall be suitably constructed of high-quality ingredients and shall be certified by the manufacturer to be suitable for this intended use. Pigmented polyvinyl or polyethylene plastic, rubber, asphalt, or similar materials that are highly resistant to bacteriological deterioration shall be acceptable base materials for buried membrane linings.

The fabricated membranes shall be uniform throughout and shall be free from dirt, oil, foreign matter, pits, tears, holes, or other defects that can affect their serviceability. They shall be packed so as to prevent damage from rough handling during shipment and so as to facilitate placement at the job site. Each package shall be marked with the name of the material, the manufacturer's name or symbol, the quantity contained therein, and the thickness or unit weight of the material.

Flexible membrane liners of the materials shown shall equal or exceed the physical requirements listed in Table 1 (polyethylene and ethylene copolymer plastic film); Table 2 (reinforced rubber sheeting); and Table 3 (unreinforced rubber sheeting). Polyvinyl chloride plastic sheeting shall meet the requirements indicated in ASTM-D-3083.

Tables 1, 2, and 3.